* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the manufacturing process of a plasma etching device and a device. It is adapted for the manufacturing process of the successive processing device using the linear super-high-density plasma excited especially using microwave and laser, and the device using this about processes, such as membrane formation, etching, flattening, washing, and a hydrogen termination, and more suitable for details.
[0002]
[Description of the Prior Art]Minuteness making progresses and a semiconductor device in recent years has indispensable flattening [in / in connection with it / a process]. The process of this flattening has now many problems, such as homogeneous reservation, reproduction of polished abrasive, processing of a high concentration drug solution which are used, although CMP (ChemicalMechanical Polishing) is used abundantly. If an important semiconductor process has control of particle, it is also necessary to isolate only CMP in another area.
[0003]In the process of the actual condition which puts a wafer surface to the atmosphere, surface natural oxidation film control is important. A Si surface, a surface of metal, etc. by which especially the high concentration dope was carried out oxidize very easily. This natural oxidation film causes various device performance degradation the rise of a rise and wiring resistance of degradation and contact resistance of the oxide film characteristic at the time of gate oxidation, etc.
[0004]The roughness of a Si surface is one of the factors which carry out direct influence to the performance fluctuation of a device. It must be difficult to obtain the flat surface to an atomic order, in addition to CMP, it must repeat sacrifice oxidation, and must perform it. Therefore, not less than about 800 ** and prolonged heat treatment will certainly be needed. Although flattening processing using hydrogen is also put in practical use, it has the same problem for the prolonged high temperature process too over 900 **.
[0005]The washing process is performed now using wet process. In semiconductor manufacture, the contaminant by which it is generated consumes a lot of ultrapure water and drug solutions, in order to remove it, although it is little very much in many cases.
[0006]
[Problem(s) to be Solved by the Invention]Even if it uses the plasma device used now, it is possible to perform processes, such as flattening, and washing, natural oxidation film removal and a hydrogen

termination. however, the plasma currently generally used -- working pressure -- several -- several [from mTorr] -- the working speed which it is Torr, and only a 10 ^{12}1/cm^3 grade is acquired by the case where plasma density is high, but is obtained at this time -- at most -- several -- several [from nm/min] -- it is a micrometer/min grade.

[0007]In order that many plasma devices may operate with low pressure, they must perform vacuum suction and atmosphere release, and a load lock mechanism is also required for them. therefore, each process is not performed sequentially, moving in the isolated space -- take -- there is nothing.

[0008]On the other hand, if a process is performed forming linear plasma and moving a wafer continuously, continuous processing is possible, but. For example, supposing it carries out continuous processing of the plate (300 mm x 300 mm) in one-sheet 1 minute, Processing of 1-mm width must be completed in 0.2 sec (supposing [Namely,] it processes the 1-micrometer depth, working speed, 300 micrometer/min), and working speed high several figures is required compared with the conventional plasma device.

[0009]On the other hand, although there are a using high frequency as high-pressure plasma device parallel plate type continuous processing device and a spread type processing device using microwave, In the case of high frequency, only the plasma whose density is also comparatively low is acquired on a large scale [a peripheral circuit] difficult [the electric design for exciting plasma with sufficient homogeneity]. The device which is performing the conventional microwave excitation, Since diffusion length required in order to use the homogeneity of that from which surely high-density plasma is acquired by the part currently excited is needed, a device is enlarged, In order to reach a plate after the ion and radical in plasma also repeat the frequent collision with atmospheric pressure, by the part used for actual processing, ion and radical density will decrease remarkably.

[0010]In order to realize such a continuation distance and to raise working speed several figures, it is indispensable to form high-density plasma in a line near the plate surface.

[Means for Solving the Problem]

[0011]It performs surface treatment of a work, moving a relative position of a work and plasma continuously, a plasma etching device of this invention forming linear plasma using electromagnetic waves, and keeping the work surface level to said line plasma.

[0012]As one gestalt of a plasma etching device of this invention, said electromagnetic wave is microwave.

[0013]As one gestalt of a plasma etching device of this invention, said electromagnetic wave is laser.

[0014]As one gestalt of a plasma etching device of this invention, working pressure is 0.1 or more mTorr.

[0015]As one gestalt of a plasma etching device of this invention, working pressure is abbreviated ********.

[0016]Plasma using mixed gas of at least one and rare gas among oxygen, nitrogen, ammonia, hydrogen, and fluoride as one gestalt of a plasma etching device of this invention performs membrane formation on the work surface directly.

[0017]Plasma using mixed gas of at least one and rare gas among material gas and hydrogen, oxygen, and nitrogen as one gestalt of a plasma etching device of this invention performs CVD film formation on the work surface.

[0018]The work surface is etched by plasma using mixed gas of at least one and dilution gas among material gas and hydrogen, and oxygen as one gestalt of a plasma etching device of this invention.

[0019]Plasma using mixed gas of at least one and dilution gas among material gas and hydrogen, and oxygen as one gestalt of a plasma etching device of this invention performs at least one of washing on the surface of a work, and flattening of a metal surface.
[0020]Plasma using dilution gas and mixed gas of hydrogen as one gestalt of a plasma etching device of this invention performs at least one of flattening on the surface of a work, natural oxidation film removal, and hydrogen terminations.
[0021]A processing device is cleaned by plasma using mixed gas of at least one and dilution gas among material gas and hydrogen, and oxygen as one gestalt of a plasma etching device of this invention.
[0022]As one gestalt of a plasma etching device of this invention, dilution gas contains at least one of helium-Ne-Ar-Kr and Xe.
[0023]As one gestalt of a plasma etching device of this invention, material gas of CVD contains at least one of SixHy, SiHxCly, and organic metal gas.
[0024]As one gestalt of a plasma etching device of this invention, material gas of etching and chamber cleaning contains at least one of NF_3, fluorocarbon, SF_6, and CO_x.

[0025]As one gestalt of a plasma etching device of this invention, material gas in etching, washing, and metal flattening contains a halogen system element.
[0026]Halogen gas used in etching, washing, and metal flattening as one gestalt of a plasma etching device of this invention is chlorine and bromine.
[0027]As one gestalt of a plasma etching device of this invention, material gas used for flattening contains at least one of Si_xH_y and SiH_xCl_y.

[0028]As one gestalt of a plasma etching device of this invention, effectual process speed is controlled by changing radial plane width of electromagnetic waves.
[0029]As one gestalt of a plasma etching device of this invention, a hermetic seal is performed by forming a viscous flow in a gap between a work and a device.
[0030]It is being fixed to a stage which a work moves to one as one gestalt of a plasma etching device of this invention.
[0031]as one gestalt of a plasma etching device of this invention, microwave sets all over the radial plane to plasma -- abbreviated ** -- it is in phase and is supplied.
[0032]As one gestalt of a plasma etching device of this invention, protective film formation with high corrosion resistance is carried out to a member surface of a conveying machine of a work.
[0033]As one gestalt of a plasma etching device of this invention, at least two or more plasma etching devices of a statement are connected with claims 6-11, and two or more processes are processed continuously.
[0034]A water removal mechanism is connected as one gestalt of a plasma etching device of this invention.
[0035]As one gestalt of a plasma etching device of this invention, ** Gas Division in a device is heated from 50 ** to 250 **.
[0036]As one gestalt of a plasma etching device of this invention, shape of a work is a plate.
[0037]As one gestalt of a plasma etching device of this invention, at least some works are semiconductors.
[0038]As one gestalt of a plasma etching device of this invention, at least some works are silicon.
[0039]As one gestalt of a plasma etching device of this invention, at least some works are glass

substrates.
[0040]As one gestalt of a plasma etching device of this invention, at least some works are resin substrates.
[0041]A plasma etching device using plasma excited by electromagnetic waves of this invention controls dissociation and excitation of material gas by forming a gas reservoir style which becomes a plasma formation part from more than two-layer at least, and choosing a type of gas supplied to each gas stream.
[0042]A manufacturing process of a device of this invention processes at least a part into 25 and 28 with the plasma etching device of a statement from 11 and 23 from claim 6.
[0043]A device of this invention is processed into 25 and 28 by at least part with the plasma etching device of a statement from 11 and 23 from claim 6.
[Embodiment of the Invention]
[0044]For example, in the case of atmospheric pressure, the densities of a gas molecule are 10^{20} molecule / cm^3 grade. Supposing the rate of the gas molecule to ionize is 1/10,000, plasma density 10^{16} ion / cm^3 grade, Since the still more radical percentage is about several percent, it can form extraordinary high density plasma [say / a radical density 10^{18} radical / cm^3 grade]. That is, it becomes possible to improve working speed triple figures from 2 by using this super-high-density plasma compared with the conventional plasma process, for example, also when several micrometers processing is required, a process is completed by the processing time of about hundreds of msec. For example, it is also possible to process processing of the plate of 300-mm wafer equivalent area in tens of seconds after 1 routing-counter second.
[0045]If it is made to operate with high voltage, it will become possible to prevent the contamination from the outside, and the back run of a resultant thoroughly by controlling the air current of the plate circumference, and the necessity of sealing process space thoroughly will be lost. Since it is possible in that case to perform separation with the external world by air current control (air curtain), the time of vacuum suction and atmosphere release is shortened, and a load lock mechanism also becomes unnecessary. It becomes processible [the plate by the assembly line (the chamber which performs two or more processes is made to adjoin the carrying path using a caterpillar belt roller etc., and it is processed continuously) which was thereby former completely impossible].
[0046]Before one process finishes with arranging two or more process units adjacently from the ability of the process which furthermore continued to be processed continuously, the following process can be started, and shortening of process time is attained. In this case, it is necessary to arrange all the working speed in each process identically. For example, what has late working speed increases the input energy to plasma, and can respond by arranging the chamber which performs the same process besides the measure of making plasma density into high density more to two or more series. Since it is possible to change effectual process time by making variable the line width of the direction of movement of a plate of a plasma formation field, it is also possible to adjust effectual process speed, without changing a process condition.
[0047]The plasma used by this invention is mainly excited by microwave. Frequency of microwave is a tens of GHz electromagnetic wave from hundreds of MHz. Since these discharge is electromagnetic wave excitation, it can excite plasma, for example via an insulator layer. The irradiation energy of the ion from plasma can be reduced to several electron volts or less by exciting on higher frequency, and contamination by sputtering from the material which constitutes a chamber can be controlled. When

high frequency is used temporarily, if exciting line width is changed, the mechanism in which the impedance of a system changes and impedance is actively changed into the inside of a power supply circuit is required. However, change of line width is possible for the case of microwave only by changing the width of a slot, for example, and change of the power supply circuit composition accompanying it is unnecessary.

[Work example 1]

[0048]Hereafter, an example of the embodiment of this invention is explained using a drawing etc.

[0049]Drawing 1 is a direction-of-movement section schematic diagram of a plate of this device. As for the plasma excitation part 103, interception with an external atmosphere is performed by the gap of the chamber wall 100 and the conveying machine 104. By setting the pressure of each part to $P_3>P_1>P_2$ at this time, about the gap of the chamber wall 100 and the conveying machine 104, it is possible to form a viscous flow, and the disclosure to the chamber exterior of process gas can be prevented about it. In order to heighten the effect of this leakage control, it is desirable for the flow between the chamber wall 100 and the conveying machine 104 to be laminar flow.

[0050]If the structure of each part of a device is determined and the pressure of P_1, P_2, and P_3 will be determined since the conductance of each gap is determined as a meaning, The leaked flow rate of a between [the plasma generating part 101 and the conveying machine 104 (i.e., between the flow to a plasma excitation part, the chamber wall 100, and the conveying machine 104) (i.e., the exterior)] can be set up. Therefore, this device can specify a gas mass flow, if there is even a mechanism in which a pressure is specified. What is necessary is to control only a pressure by this and a flow instrument is not needed by it to realize as a simpler device. Though natural, even if it uses a flow instrument, it cannot be overemphasized that arbitrary flows are obtained.

[0051]The A-A' section schematic diagram in drawing 1 of this device is shown in drawing 2. 102 points out the plate in which a process is performed. This plate temporarily for example, when anxious about generating of a slip etc. like a silicon wafer, when the homogeneity at the time of performing heating etc. is referred to as liking to improve, and when, By installing a plate on a larger stage than a plate, and conveying the whole stage with the conveying machine 104, the damage to a plate can be prevented and a homogeneous high process can be performed.

[0052]If the plate which is not a rectangle is used, the seal characteristic between the chamber wall 100 and the conveying machine 104 will change reflecting plate shape, and the pressure fluctuation of process space will arise. Therefore, it is desirable to take the structure where the plate 102 is buried in the conveying machine 104 so that the process side of the plate 102 and the conveying machine 104 and the interval of the chamber wall 100 may become equal. When using a circular silicon wafer etc. which are used abundantly now, having a radius comparable as a silicon wafer in a stage -- the thickness of a silicon wafer, and abbreviated ** -- the slot of the same depth can be formed and the homogeneity of the process in an edge part can be improved by arranging a wafer surface and stage surface height.

[0053]When performing heating etc., using a stage, reservation of the homogeneity of the heat in the whole plate surface is important. For that purpose, it is desirable to use thermally conductive high construction material for the construction material of the part which touches a wafer at least in a stage. AlN-aluminum$_2O_3$ is desirable if it is an insulating material.

[0054]When using it with high voltage, it is desirable by carrying out vacuum suction of the plate rear face to secure adhesion. In this case, although a very small quantity, the diffusion to the process space of

the moisture which stuck to the plate rear face can be prevented by attracting a process or sealing gas.
[0055]If pressure control like drawing 1 is performed, it will be lost that process gas is revealed outside, but in order for the gas of an external atmosphere to mix to process gas, it is necessary to also make the chamber exterior into a high clean atmosphere. On the other hand, structure like drawing 3 is adopted and a seal becomes possible by setting up a pressure so that a pressure may fill $P_4>P_3P_4>P_1>P_2$ by the gas which blows off from the gas introducing paths 300 and 301. Since direct supply of a part of gas which blows off from the gas introducing path 301 is carried out to the plasma 103, it is desirable to consider it as the carrier gas of a process. On the other hand, since the gas in particular that blows off from the gas introducing path 300 does not reach the plasma part 103 when gas is supplied by the viscous flow, with regards to a process, there is, for example, N_2 of a high grade, etc. may be used for it.

[no]
[0056]Although it is possible to make it operate by the pressure of 0.1 or more Torr which can form high density plasma with microwave as for this device, in a low-pressure case, a separation method etc. which are different from a gas stream turning into a viscous flow and molecular flow are needed. However, in the line which adopted the case where the thickness of the film which forms membranes is thin, vacuum tunnel conveyance, etc., use by low pressure operation may be desirable.
[0057](Linear excitation method by electromagnetic waves) In order to form linear plasma using microwave, structure like drawing 4 is formed in the inside of 101 of drawing 3. This structure comprises the H plane slot antenna 400 and the equalization track 404. Slot array is formed between the equalization tracks 402 at the H plane slot antenna 400. Slot array is constituted from the waveguide center line 405 in one half of the pitches of the guide wave length by the slot 401 arranged by turns at right and left. The microwave to which the phase emitted from this slot array was equal is supplied to the equalization track 404. Although the major axis of the slot 401 is installed in parallel to the waveguide center line 405 in this example, the slot 401 may incline to the waveguide center line 405.
[0058]The H plane slot antenna 400 can substitute the structure which can be emitted to a line for the microwave to which the phase was equal. The slot array which began the E plane antenna and was formed in a circular waveguide, a coaxial waveguide, etc. can also acquire the same effect. When the major axis direction length of line plasma is comparatively short, it is usable in a horn antenna etc. Straight pipe connection besides T character branching is possible for the electric supply to the H plane slot antenna 400. When other structures are adopted, connection is made using a coaxial waveguide converter, a circular-rectangular waveguide converter, etc. Although the system using a progressive wave is also possible, it is desirable to short-circuit a termination, if feeding efficiency etc. are taken into consideration, and to use as a resonance system using a tuner etc.
[0059]The equalization track 402 is a parallel plate track (flat rectangular waveguide which uses center line 405 direction as a major axis practically) for forming the wave front of the microwave equalized more spatially using the microwave to which the phase emitted from slot array was equal. The microwave discretely emitted by this track from each slot 401 is equalized, and the wave front which has uniform intensity by center line 405 direction is formed. When such an effect is acquired and it designs especially by a resonance system, It is desirable to make the height of the space lengthwise direction of the equalization track 404 into the height of the integral multiple of the half-wave length of the guide wave length (the free space wave length which took into consideration the dielectric constant of equalization track 402 inside approximately may be sufficient because of flat rectangular waveguide.) of

the equalization track 402. The resonance condition of equalization track 402 lengthwise direction will be fulfilled by doing in this way, and efficient excitation is attained.

[0060]The microwave equalized on the equalization track 402 is emitted to plasma from the slit 403. Effectual process speed can be changed by making width of the slit 403 variable.

[0061]Since the effect of diffusion of plasma is not acquired when a pressure is high, the shape of the plasma formed correlates about the intensity of microwave strongly. Therefore, it is desirable to take the composition in which uniform discharge is possible like drawing 5. On the other hand, since diffusion of plasma can be expected when working pressure is low, the same effect can be acquired even if there is no equalization track. When a uniform wave front can be independently formed like a horn antenna, similarly an equalization track may not be. What is necessary is just to form a slit in the front face of an antenna, when deflecting excitation width in the case of a horn antenna.

[0062]It is common in all the supply systems of plasma, and if discharge breaks out in the course to a microwave emission surface, microwave will be consumed by a discharge section. In order to prevent discharge in an unnecessary part, the technique which is filled up with gas, such as SF_6 which is hard to discharge for a course, and which is maintained at vacuum suction or the pressure which is pressurized and is hard to discharge in which it is filled up with a dielectric is used. When filled up with a dielectric, since it is a propagation path of microwave, it is desirable to use SiO_2 (thermal conductivity: -1.4 [W/m-K]), aluminum$_2O_3$ (thermal conductivity: -10 [W/m-K]), AlN, etc. with few losses (thermal conductivity: -160 [W/m-K]). Ion irradiation and since it is put radically and becomes an elevated temperature, thermally conductive high AlN of especially the plane-of-composition part with plasma is desirable.

[0063]The process of a low damage as well as microwave can be performed, and laser can be considered as an excitation source which is a comparatively simple equipment configuration and can obtain high density plasma. In the case of laser, since frequency is very high, the reflection from plasma does not need to consider that microwave sees. However, the diffusion region of the high excitation part of the plasma temperature near the focal plane and the plasma of the circumference of it can be formed by setting it as the position which left suitably the focal plane (it becomes linear shape in the ** case) from the wafer surface, and the same treatment as microwave becomes possible. It is easily realizable to condense laser a line and uniformly by using the optical system which combined a transmission-and-refraction system and reflective refractive media. As laser which can be used, high-output solid state laser, excimer laser, Cu steamy laser, etc. including the carbon dioxide gas laser and the YAG laser which are obtained are raised. Especially carbon dioxide gas laser tends to construct an optical system, it is high power, and since treatment is also easy, it is preferred.

[0064](Separated supply of two or more sorts of gas) When performing plasma excitation using microwave and electron density becomes high from cutoff density, it is reflected by plasma and it becomes impossible for microwave to spread the inside of plasma. At this time, excitation of plasma is performed from the surface of plasma in the field several times the depth of skin depth delta=(2/omegamusigma) $^{1/2}$ which is the invasion length of microwave. As for the angular frequency of microwave, and mu, amplitude permeability and sigma of omega are the conductivity of plasma.

[0065]If electron density is lower than cutoff density, i.e., microwave chooses the conditions which can spread the inside of plasma, The problem of that microwave is irradiated by the plate, unusual heating of a plate occurs, a standing wave arises by the reflected wave from a plate or a chamber wall, and plasma

becomes uneven, not being excited efficiently arises. Therefore, in order to perform an efficient and uniform process, the process which used cutoff mode will be performed, but although plasma is formed also in parts other than delta depth in that case, this is based on diffusion, and electron temperature becomes low compared with an excitation part especially.

[0066]When plasma excitation is generally performed using gas other than rare gas, there is a tendency for electron density to fall. There is gas it is more desirable for dissociation not to follow depending on a process. That is, in order to acquire the stable plasma, it is desirable for rare gas to exist in an excitation part, and it is desirable to avoid and supply an excitation part for supplying adequately the gas which wants to prevent dissociation.

[0067]Drawing 5 is a sectional view of the device which makes such separated supply possible. The gas which wants to prevent dissociation for the gas it is better to promote rare gas and dissociation from the supply system 500 is supplied from 501. By determining suitably the structure and the gas mass flow of the supply system 500 and the supply system 501, and also the supply system 301, the laminar flow structure laminated to the plasma excitation part 103 can be formed.

[0068]The details with the laminated laminar flow structure of the plasma excitation part 103 are shown in drawing 6. From the plasma radiation side 600, by the part 601 in which the skin depth carried out depth invasion, the emitted microwave becomes one 1 / times the intensity of e (**0.368), and is decreased exponentially. Therefore, if it separates from the several times as many distance plasma radiation side 600 as a skin depth, excitation of the plasma by microwave can be disregarded. The plasma of the field which got used more is diffusion plasma, and electron temperature cannot dissociate a gas molecule easily low. The gas stream 605 and the supply system 501 which were supplied from the supply system 500. And the gas molecule contained in the gas stream 607 by setting the boundary 602 with the gas stream 607 supplied from the supply system 301 as a position further than the field 605 upon which microwave has trespassed moves in the plate surface 603 top, without dissociating. When especially the gas stream 606 and the gas stream 607 are laminar flow, since exchange of the gas molecule contained in the gas stream 606 and the gas stream 607 is controlled, the very high separation effect can be expected.

[0069]For example, in CVD, it is desirable to make the gas stream 606 into rare gas, and to make the gas stream 607 into addition gas, such as various material gas, hydrogen, oxygen, and nitrogen. When performing especially CVD of a semiconductor or metal, if material gas is contained in the gas stream 606 side, a semiconductor and metal are formed in the plasma radiation side 600, and absorb and reflect microwave, and microwave stops entering effectively, and it becomes impossible to excite plasma. Especially Therefore, Si epitaxial growth, various SiO_2 film formation, The gas stream 607 should be made to contain the gas by which dissociation called Si_xH_y, SiH_xCl_y, organic metal gas, etc. which are used for metal thin film forming, metal oxidation and nitride formation, and high and a ferroelectric formation character takes place easily.

[0070]Since the material gas with the basis of an organic system has an effect of covering nature being improved by the effect of various bases at the time of membrane formation, the more nearly quality membrane formation of it is attained by dissociation not being promoted. What is necessary is just to choose helium, Ne, Ar, Kr, and Xe suitably including several sort mixing etc. according to material gas or a process depending on the case, since a state, generation radical species, etc. of plasma change with types of gas although the low rare gas of dilution gas of chemical reactivity is desirable.

[0071]In RIE, the supply separation according to the function of gas is needed. For example, it is better for the radical which determines the selection ratio of the substance of Si and others to be C-CF_x with C-C combination, and not to dissociate, by the time CF_x system is radical when using the system of C_4F_8/ CO/O_2 / rare gas. Therefore, C_4F_8/O_2 in order to prevent dissociation and to stabilize plasma to the gas stream 607 side. In order to supply C, the rare gas of CO and dilution gas with which it is better to promote dissociation can form the plasma which realizes high etching of a selection ratio by supplying the gas stream 606 side. In addition, highly precise processing is attained by separating and supplying material gas, such as halogenides, such as fluorocarbon, chlorine, a bromine system, CO_2, and SF_6.

[0072]When performing flattening processing of Si, etching is performed from the hydrogen diluted with rare gas, but a little Si_xH_y and SiH_xCl_y can be added to process gas, and the effect of flattening can be improved by considering it as a competitive reaction. The membrane formation to the plasma radiation side 600 can be prevented by supplying the addition gas in such a case to the gas stream 607 side.

[0073]Even when using the same gas, an effect which is different by changing an introductory route by the use may be acquired. For example, when performing direct oxidation and nitriding directly, radicals generated by to which gas, such as oxygen, nitrogen, hydrogen, ammonia, and fluoride, is supplied change. A radical is formed even when these gases are temporarily supplied to the gas stream 607 which cannot dissociate easily. The main processes in which a radical is formed at this time are indirect processes by the collision with the ion radical of the rare gas excited by microwave, etc., and the radical generally directly excited by microwave differs in them also from radical species and density. That is, since two or more reaction atmospheres are realizable according to an introductory route, the membrane formation from which membrane formation speed, membraneous quality, etc. differ is realizable.

[0074]When there are radical ion etc. which are efficiently excited by a certain specific intermolecular collision, An excited molecule is efficiently excited by supplying an excited molecule to 606 and supplying an excited molecule to 607, excitation by microwave is made as for an excited molecule to the minimum, and it can form the target radical ion etc. effectively. For example, by Kr excitation, the membraneous quality and membrane formation speed which could form the oxygen radical which is hard to generate and are different can be obtained by passing the gas which diluted with Kr oxygen which is material gas 607 about the gas which added a small amount of heliums 606 to Kr which is dilution gas when performing direct oxidation. This can be improved more in the characteristics, such as selectivity and membraneous quality, also in processes, such as a hydrogen termination, by determining the supplying form of gas according to the target material [the same argument is possible and] and a working result.

[0075]Since the mean free path is especially short in the process in high voltage also in which process, the ion irradiation to the plate surface can be disregarded, and the process of being damage-free is possible. However, when a mean free path cannot be disregarded with low pressure but the damage by ion irradiation poses a problem, a damage can be reduced by using the rare gas whose reliance mass and atomic radius are [when] large as Kr or Xe.

[0076](Surface treatment) The part which wants to prevent water adsorption in this example which makes the process of these possible, All the device table sides that may be put to a high-concentration radical form aluminum in the conventional SUS316L material using the high concentration aluminum

addition stainless steel added (- 4.16%), oxidation reduction competition atmosphere **** which added the moisture of 1 ppm to the hydrogenation Ar 10% -- by carrying out temperature up to 900 **, the surface very stable aluminum oxide passive state film was formed. As opposed to corrosive high chlorine system gas and fluorine system gas, there is corrosion resistance outstanding also to the high concentration radical formed of high density plasma by this, and even if it performs chamber cleaning using H_2, NF_3, etc., the metallic contamination to a plate, etc. do not occur at all. By excelling in the moisture desorption characteristic, since catalyst nature is low, process space is supplied, without gas, such as Silang which reacts for moisture very sensitively, also deteriorating.

[0077]The aluminum fluoride and the magnesium flux mixing protective film on Cr_2O_3 protective film with the high moisture desorption characteristic, and an aluminum magnesium alloy, In consideration of processability, radical character-proof, the water adsorption characteristic, and ********, material can be suitably chosen for the fluoridation nickel protective film on the surface of nickel plating, etc., and it can be considered as a reliable device by performing protective film formation. Examples, such as a presentation of the main protective films and formation conditions, are shown.

[Table 1]

保護膜組成	Cr_2O_3	FeF_2	AlF_3 MgF_2	NiF_2
主な母材	SUS	SUS	Al－Mg系合金	任意（Niメッキ表面）
形成温度［℃］	500	220	350	350

形成雰囲気	不活性ガス H_2 10% H_2O 100ppm	F_2	F_2	F_2
特徴	オゾンおよび酸素ラジカル外に適応可能	フッ素系ガスに対する耐腐食性が高い	装置の軽量化が可能 水素外に適応可能	母材に対する制限が少ない 水素外に適応可能

[0078](Continuation-izing of two or more processes) If an equipment configuration like this patent is adopted, it is easily possible to integrate two or more processes compactly. The sectional view is shown in drawing 7, and the perspective view is shown in drawing 8. Drawing 8 has omitted the isolation wall 706. 700 to 702 is a chamber simple substance which includes drawing 1, drawing 3, or structure like drawing 5 in an inside. 703 to 705 which contains auxiliary machinery, such as a heater, in this is attached.

[0079]When overheating a plate, and uneven heating induces generating of a slip etc., places other than a process part (plane of composition of the plasma excitation part 103 and a plate) also need to be maintained at a uniform temperature. Therefore, while starting the heating sequence of 703 in the place where all the plates that have run in the 709 directions went into the heating range of 703, It is desirable to perform heating by 705 and to start cooling, heat dissipation, or a heating stop sequence uniformly all over a plate with an end until the process of the whole plate surface is completed. When the process

temperature performed especially by 700, 701, and 702 differs, composition like drawing 7 is desirable. It is not necessary to give a heating machine style to the stage which moves to a plate and one depending on the case, and to perform heating in the 703rd grade. In this case, even if the process temperature in each stage differs, since it is satisfactory, the installation interval of a simple substance chamber can be narrowed even to the direction-of-movement length grade of an abbreviated ** plate.

[0080]For example, if the plate surface will be put to the atmosphere during conveyance between simple substance chambers even if separation of process atmosphere and the chamber exterior is performed like drawing 5, in 1 second, the moisture near the amount of parallel adsorption moisture will adhere to the plate surface from the atmosphere, and moisture will be carried into process atmosphere. Therefore, the isolation wall 706 is introduced into drawing 7. Thereby, the water adsorption to the wafer under conveyance between simple substance chambers can be prevented. When making it operate with low pressure from the pressure near the atmospheric pressure, the isolation wall 706 is indispensable and a load lock mechanism is needed for the device foremost part and the backmost part.

[0081]the gas which comes out from the exhaust port 707 -- purity -- high -- high -- since it is pure purge gas, reuse is easily possible. Since gas is emitted outside only by the outlet 708 of the both ends of a cluster device as a result, the amount of consumption of purge gas can be reduced.

[0082]When the plate has been first introduced in this device, the mechanism in which the moisture etc. which have stuck to the plate surface are removed is not formed. However, such composition is enough when 700 which performs the first process is performing processes using plasma, such as water removal, oxide film removal and exfoliation or washing.

[0083]The example of composition when the water removal in non-plasma is required is shown in drawing 9 in early stages. The water removal mechanism 900 removes the moisture on the surface of a plate using lamp radiation. What is necessary is just to use the excimer laser etc. which can remove only a part for the surface water of aggregate, when heating of the plate by lamp radiation etc. pose a problem although IR lamp etc. may be used. The technique of making the high grade purge gas which takes a distance suitable from a plate feed port to the chamber 700 even if it does not form the water removal mechanism 900, desorbs moisture by heating a plate, and flows from 700 absorb moisture is also possible.

[0084]Drawing 9 has also proposed the structure about a heating system. What is necessary is just to heat all the fields continuously like 903 by two or more chambers, when processing by the same process temperature is possible. In that case, since uniform heating in the whole plate surface is made possible, heating which does not cause the distortion in a slip plane, etc. is attained by installing the heating units 901 and 902 in which a temperature-up temperature fall is possible in the foremost part and the backmost part, respectively.

[0085](Double-sided simultaneous processing) By the technique of these, the water removal on the upper surface of a plate is possible. However, when the moisture nonproliferation from the above plate lower parts is difficult, composition like drawing 10 is adopted. The chamber 1000 has a plasma excitation part in up-and-down symmetry to the plate 102. By making this pass the plate 102, the water removal of plate both sides is simultaneously possible.

[0086]By plate both sides, this technique is effective, when water removal, oxide film removal and exfoliation or washing, etc. is required, and it is used for it, being suitably intermingled with the chamber 700 grade of only upper surface processing.It cannot be overemphasized that mechanisms

about the water removal in these continuous devices can be used also to a simple substance chamber.
[0087](Prevention from deposition, such as a reaction by-product) It is not necessary to necessarily secure homogeneity, such as a presentation of the gas of the direction of movement of a plate, and a partial pressure, in this device. Therefore, although it is also possible to have said that the material gas of only a reaction initial complement was added in CVD etc., and it controlled the material gas concentration of an exhaust side on a very low level, generally not only CVD but the resultant in RIE, etc. will be deposited on a chamber wall etc., for example. It has an adverse effect on processes -- this sediment serves as a source of raising dust in a device -- in many cases.
[0088]In CVD (MO-CVD) using the organic metal gas by which research is advanced these days, since the steam pressure of liquid gas is low, it is necessary to hold a gas supply course to an elevated temperature. On the other hand, stable gas supply becomes if temperature up of the chamber wall is preferably carried out to about 250 ** from 50 **, it is possible to reduce the rate of sedimentation and dew condensation on the level of several figures, and it is possible to decrease the frequency of chamber cleaning or a maintenance sharply, and possible. However, in spite of not carrying out by taking such measures, it cannot be overemphasized by cleaning a chamber periodically using NF_3, H_2, and the plasma to which O_2 was added especially in the case of the organic matter that it is possible to keep the state of a chamber good. That in which the gas added in the case of cleaning has a cleaning effect to various substances, such as fluorocarbon, SF_6, and CO_x, is also used suitably.

[0089](The system integration and line construction by a successive processing device) As stated until now, this device can realize the flow production line in the atmospheric pressure neighborhood. Under the present circumstances, membrane formation, etching, flattening, and washing processes other than PVD and ****** etching can consist of these devices. the main processes of remaining -- exposure -- and they are washing and ion implantation in part.
[0090]If art, such as for example, laser doping, is used, since it is realizable with the same composition as this device, all the processes other than PVD and ****** etching can realize ion implantation under atmospheric pressure power. That is, it becomes possible to combine about 90 percent like this device from 80 percent of processes, and to build a line, and the ultra high-speed TAT compact factory line which could not be realized until now is built. Since there is no anisotropic etching especially in the FPD production including LCD in necessity, whole process atmospheric pressure production is attained, and an innovative factory line can be built.
[0091]This device is the purpose and micro processing, such as fine circuit processing and micro-machining, a plate, Compound semiconductor wafers which are semiconductor substrates, such as Si-SiC, a diamond and germanium wafer, and GaAs, It cannot be overemphasized that the effect that resin substrates, such as glass and a quartz substrate, a fluorocarbon system, a polyimide system, etc. which are used for the silicon on sapphire used for a high-speed operation circuit, a liquid crystal, etc., are also the same is acquired.
[Work example 2]
[0092]The washing station in this invention is explained. Although this is washing art called dry washing, it is possible to obtain the conventional cleaning effect and backwashing rate of several or more figures, as mentioned above with this device. Selection and the effect of the gas in some subprocesses are described.
[0093]The thing equivalent to the conventional sulfuric peroxide clean is realized by the plasma process

which contains oxygen in process gas. By microwave, the high-concentration oxygen radical by which excitation generation was carried out oxidizes, decomposes into H_2O, CO_x, NO_x, SO_x, etc., and removes the organic matter adhering to the plate surface from the surface.

[0094]The thing equivalent to the conventional chloride filtered-water washing is realized by the plasma process which contains chlorine or bromine in process gas. Generally, especially a metaled chloride and bromide have low steam pressure, and it sublimates them easily. Therefore, the mineral constituent after oxidizing the metal impurity and organic matter on the surface of a plate by forming a high-density chlorine radical and a bromine radical is removable. Anyway, processing advances by the chemical reaction according [the flattening processing in this device] to the radical and ion of hypomotility energy. Flattening of a metal surface is possible in the same process. However, since a high throughput is required, material gas concentration, a pressure, incidence power, etc. generally need to be large [flattening of a metal surface] compared with washing.

[0095]Along with a washing process, an important process has natural oxidation film removal and hydrogen termination processing. This is performed by both with rare fluoric acid. However, there is a fault that the particle which the F-potential of a silicon surface and particle was not controlled by this process, but was removed by the previous process will carry out the reattachment. On the other hand, the hydrogen end face of rare fluoric acid and the level can be formed, without particle carrying out the reattachment, if oxide film etching and a hydrogen termination are performed using the dense hydrogen radical excited by microwave.

[0096]In plate washing by this device, removal of an organic matter and an inorganic substance is possible. Especially, since the backwashing rate is very higher conventionally than a device, it can respond even to a comparatively big foreign matter. However, it is difficult to correspond only by a plasma process about removal of the particle which is another element. If the working pressure of this device is set as an abbreviated ******** grade, combination with the conventional washing station is easily possible. Since publicly known few water type washing stations can be combined with the conveyance system of this device as it is, a perfect washing process is realizable by including in the inside of this device. If such a form is taken, time, such as vacuum suction, atmosphere release, conveyance between devices, can be shortened substantially, and reduction of a footprint and shortening of process time can be aimed at.

[0097]When plasma was conventionally used for dry washing, it had problems, such as damage generating to the film by a high energy ion collision, and an oxide film dielectric breakdown originating in the heterogeneity of plasma. However, plasma potential [of the plasma acquired under high voltage conditions especially in the device of this invention / itself] is in a very low level, many of these problems are avoided, and ideal dry washing art is established.

[0098]This invention can be carried out in other various forms, without deviating from the pneuma or main features. Therefore, at all points, the above-mentioned example is only mere illustration, and must not be interpreted restrictively. A claim shows the range of this invention and it is not restrained at all by the specification text. All of the modification and change belonging to the equivalent range of the range of a claim are the things of this invention within the limits.

[Effect of the Invention]

[0099]Most fine circuit formation processes of a semiconductor can be made into an atmospheric pressure process by using this device, and productivity can be improved by leaps and bounds from processing covering a large caliber being possible.

[Translation done.]